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MECHANICS' MAGAZINE.

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

...VII.—New Series.—Nos. 8 & 9. Vol. I.

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Oct. 15 1838.

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		87

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Adrian and Toledo,	"	2
Lake Wimico and St. Josephs,	Florida.	2
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From the annexed testimonials, it will be seen that the Engines of M. W. B., are not inferior in capacity of performance to any Engines in this, or any other country; while at the same time they combine several improvements secured by patent, and many advantages not to be found in other Engines.

One very important advantage is, the simplicity of their construction and arrangement, by which every part of the machinery is perfectly accessible while the engine stands upon the road.

The improvement in the construction of the cranks is one of *great importance*, obviating the liability to break, an occurrence so common to most locomotive engines.

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...manufactures three classes of Engines, Nos. 1, 2, and 3. Most of the above ... to the No. 3, or smaller class, and many of them have been in use from two to ... The present engines are very much improved. One of the first class, recently ... over the Columbia road, part of which has an ascending grade of 45 feet ... loaded cars weighing 187 tons, equal to about 700 tons on a level.

...ines or machinery promptly executed, on application to M. W. BALD... Philadelphia, or to E. L. MILLER, Manager, for contracts in the city of New York.

...testimonials of the merits of these engines, have been received from Officers ... Superintendents of motive power, &c. &c. of several of the roads above ...

... BRANDT, Superintendent of Engines and Machinery, on the Columbia and ... Railroad, writes under date of the 11th of May, 1838:—"We have twenty-... engines, several of which have been in use since the fall of 1834. Two of your ... commenced running Feb. 23d, 1837, and travelled 35,695 miles, up to the ... and cost for repairs during the above-mentioned time, one cent and eight ... Eight engines of the first class, have travelled from the 1st of January, ... to the 1st of May, (4 months) 40,369 miles, made 653 trips, drawing 16,326 cars; the ... for these four months, I am now unable to show, as our books are not posted, ... you that the expenses this year will be less per mile than any former years. ... class recently built, has drawn over the Columbia road, part of which has an ... grade of 45 feet per mile, 35 loaded cars, weighing 187 tons, equal to about 700 ... and travelled from 8 to 12 miles per hour, except on the wooden track. This ... train that has ever passed over the road."

... ...MAN, Resident Engineer of the Long Island Railroad Company, writes ...: "We have two engines of class No. 3, of your manufacture, which have ... since May, 1836. Their performance is worthy of the most unqualified praise. ... an ordinary load, 15 freight cars, weighing 5½ tons each; and to show their ... have frequently taken 20 cars without difficulty, up an ascent of 35 feet to ... have carried 4 cars up a grade of 211 feet per mile for a distance of 2,100 ... average speed for freight is 10 miles, and for passengers, from 20 to 25 miles per ... summer of 1837, they performed the distance of 102 miles each day, and from ... which now lies before me, it appears that under this severe usage, there was no ... of these engines for 6 months, which rendered a change in their usual time ... necessary, or caused any delay, either in the transportation of passengers or ... fully satisfied that the cost of repairs does not exceed one half that of a four ... doing the same work."

... CASH, Superintendent of motive power, on the Norristown Railroad, says un... ...May, 1838: "I take great pleasure in bearing testimony to the excellence of ... They are well adapted to light or heavy loads. With one of the small class ... nearly three years in constant service, I have drawn a train of 750 passen... ...miles of 32 feet per mile, at the rate of 14 miles per hour."

... ...ROVE, Superintendent of Motive power, on the Philadelphia, Wilmington, and ... Railroad, writes: "After an experience of several years with Locomotive ... of different roads, I am of opinion that the engines of M. W. Baldwin, are easier ... than any engines in use, and that they combine more advantages than any ... within my knowledge. They have been almost constantly running for the last ... months. The engine Brandywine, has been running 265 days, at a cost for ... of $17, and has lost but 5 days since she was put on the road. The Christiana ... 135 days at a cost of but $20 for repairs. Their average speed is 24 ... including stoppages."

... ...son, President, and L. R. SANGSTON, superintendent of the Rensselaer and ... Railroad Company, say under date of 29th of May, 1838: "We have two of ... which have been in use about three years. They *work well* in every ... and I deem it but an act of justice to say that the manufacture and materials of ... have proved to be of the highest order, and I have evidence from the official reports of ... roads, and my own experience here, that your engines will, in *performance* and ... bear comparison with any engines made in this, or any other country."

... ...WORTHY, Esq. President of the Boston and Providence Railroad Company ... 31st of May, 1838: "We have three of your Engines, which have been in ... since June, 1836. We have never had occasion to put them to their maximum ... may have carried 17 freight cars of gross weight, say 85 tons, engine and ten... ...loaded, over the road at an average speed of 10 miles per hour, including an ascent ... length, one half mile of which is 42½ feet per mile, and the remaining four and ... 21½ feet per mile. They carry ten passenger, and three baggage cars, very ... the road, at an average speed of 18 or 20 miles per hour. Your engines give ... satisfaction."

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90 " 1 " ½ " " " ⅞ " "

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L. O. REYNOLDS, Ch. Engineer.
Savannah, November 1, 1838.

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OLIVER AMES.
Salisbury, November 5, 1838. tf

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MOSES LONG.
Rochester, N. Y, Sept. 13, 1838.

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RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 8, Vol. I. New Series.] OCTOBER 15, 1838. [Whole No. 319. Vol. VIII.

Power of Traction of Locomotive Engines.

MESSRS. MINOR & SCHAEFFER:—

I have just observed, on my return to this city, after an absence of several weeks, a communication in the Railroad Journal, from C. E. Detmold, Civil Engineer, commenting upon the letter of Mr. Talcott, and also upon my remarks accompanying the same, in the first number (new series) of the Railroad Journal.

Mr. Detmold says, in respect to an error in the loads for the two lower velocities in the table to which he refers, that instead of attributing it to the circumstance of "having employed the formula of De Pambour beyond its proper limits," I have "ascribed it to the inaccuracy of the formula;" and he supports this allegation by quoting from my remarks where I say, that "the formula of De Pambour gives, under a continued decrease of velocity, a continued increase of power, and does not therefore designate the point at which it ceases to be applicable."

In this remark the fact is certainly most clearly and distinctly set forth, that there is a "proper limit" to the application of the formula, or, as I have expressed it, "a point beyond which it ceases to be applicable." I state further, and this is all I do state in reference to the character of the formula, in respect to its bearing upon the error in question, that "this point is not designated" in the formula. This is strictly true, and is so acknowledged by De Pambour, as appears in the quotation from him taken from the same paragraph of Mr. Detmold s communication with the above, where he says, that "beyond that point (alluding to the point where the power and the resistance equilibrate on the piston) the equation *may continue to give results*" which, however, will no longer be correct.

It certainly was not my intention, and in no part of my remarks can I discover that I have ascribed the error referred to, to the "errors and inaccuracies of De Pambour," as asserted by Mr. Detmold; on the contrary, I distinctly attributed it to inadvertence, resulting from the "haste" in which the table was prepared, combined with the circumstance that the formula "does not designate the point at which it ceases to be applicable," a circumstance which has probably led De Pambour himself, in at least one instance, into precisely the same error, as will appear by reference to his "practical table," p. 186;* where the resistance presented by the load, when referred to the pistons, is greater than the maximum effective pressure of the steam on the same pistons.

* Philadelphia Edition

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That there may be no misapprehension, I wish it distinctly to be understood, that this case, and any others to which I may have occasion to refer, are not alluded to with the view of disparaging the labors, or detracting in the least from the great credit due to De Pambour for his very valuable experiments, and analysis of the powers and properties of the Locomotive Steam Engine. This credit is fully awarded to him in my letter, and in my remarks, and I am compelled to say that Mr. Detmold in his "too great haste" to shield the reputation of De Pambour in a point where it was not intended to be assailed, or even threatened by me, has done me, as I conceive, an injustice.

That exceptions, such as are urged by Mr. Detmold, may not be taken to a portion of Mr. Talcott's remarks, I do not pretend to affirm or to deny. For his views upon the subject and mode of illustration, I am not responsible—Mr. Talcott is fully able in this matter to speak for himself.

I stated in my letter, while commenting upon the *general character* of the formula of De Pambour, that there were "inaccuracies in the mode of conducting and analyzing his experiments." This statement was made before the error above referred to, in the table, was observed, and had therefore no reference to it.

In my remarks, accompanying Mr. Talcott's letter, I repeated the above statement, saying, that "on a more critical examination, those defects were greater than I at first anticipated." Some of those defects I will now briefly describe.

De Pambour informs us, p. 49, that the spring balance for determining the pressure of the steam in the boiler, is the same as that commonly used for weighing, being constructed upon the same principles, and graduated in a similar manner. The parts of which the balance are composed may be designated as follows:—*

1.	Weight of the spring, represented by		S
2.	"	Rod, nut and index, "	T
3.	"	Plate, tube and foot, "	P

When the balance is in the proper position for weighing, with no weight attached, and supported by the nut, the force compressing the spring is P+S. In this situation the index is at zero; when, therefore, the balance is attached to the boiler, the lever before it can compress the spring, must overcome the weight of the rod, nut, and index, equal to T. To this must be added the force as above, P+S, necessary to compress the spring, making the whole force exerted by the lever, in sustaining the index at zero, the point at which it begins to register any effort —equal to P+T+S, or equal to the whole weight of the balance, and this, therefore, is the correction to be added to the amount pointed out by the index. This may be explained in a different manner, as follows:— The lifting effect of the foot of the balance upon the boiler is precisely equal to the weight pointed out by the index. The lever, by its upward action, exerts a force equal to this, and in addition thereto, supports the whole weight of the balance, since no portion of the latter rests upon, or is supported by, the boiler.

In the example, p. 53 and 68, where the weight of the balance is 4lbs., the

* The parts composing the spring balance may be variously arranged. The force applied may either expand or contract the spring, or the plate and tube may be attached to the rod instead of the foot, or the index may be attached to either the rod or the foot. I have adopted the arrangement in the balance used by De Pambour, as near as the same could be ascertained from his description.

correction is 4lbs. De Pambour makes it 2¾lbs. If the balance is "turned upside down," as in the case of the Vesta Engine, p. 71, the correction becomes then equal to 2P+S. The value of S not being known, the true correction, in this case, cannot be ascertained; enough, however, is known to show that in both cases it is nearly 50 per cent. greater than the amount obtained by De Pambour.

The true correction being thus ascertained and applied, and the proper allowance made for the effect of leverage, and weight of lever and disc, &c. the total pressure of the steam in the boiler is found to be a little greater by the spring balance than by the mercurial gauge.

There is another correction, not noticed by De Pambour, resulting from the conical shape of the valve, by which the surface exposed to atmospheric pressure, is greater than that exposed to the pressure of the steam.

In this case, the correction is equal to the atmospheric pressure upon the difference of the two surfaces divided by the area of the lesser one. If the diameters of the two surfaces of the valve are represented by D and *d* respectively, the correction is equal to

$$\frac{\cdot 7854\,(D^2-d^2)\,14{\cdot}7}{\cdot 7854\,d^2} = \left(\frac{D^2}{d^2}-1\right)14{\cdot}7.$$

Supposing D = 3 inches, and $d = 2\frac{1}{2}$ inches, as per page 5, the correction per square inch amounts to 6·47lbs., adding to this the error in the correction of the spring balance, as above explained, and the total *effective* pressure in the boiler will be found to be about 7¾lbs. greater than is computed by De Pambour; equal to about 14 per cent., supposing the average effective pressure in his experiments to be as high as 55lbs. per square inch.

The allowance for excess of atmospheric pressure upon the upper surface of the valve, proceeds upon the supposition that the valve is fitted closely to its seat. This closeness of fit may not exist practically, and hence the difference in the surfaces sustaining the opposite pressures may be less than is supposed above, thereby reducing the amount somewhat from the estimate. The exact amount proper to be allowed can only be ascertained by experiment.

The corrections, as applied by De Pambour to the spring balance, exhibit the effective pressure equal very nearly to that obtained by the mercurial gauge. That the pressure obtained by the latter was *too low*, is evident from the statement of his, p. 77, where he says "that the steam necessarily cools in the long passage from the Engine to the instrument, being forced to follow a metallic tube 8 or 10 feet long, by half an inch in diameter, and must consequently arrive on the mercury with a *less degree of pressure than in the boiler.*" Hence it follows, that the pressure obtained by the spring balance as corrected, was also *too low*, the results being nearly the same in both cases.

The conclusion drawn from the above, is, that the spring balance, even when applied in the usual way, is a more accurate test of the actual pressure in the boiler (when the corrections are properly made) than the mercurial gauge. There is still, however, room for much improvement in the former instrument. The plan proposed by De Pambour, p. 76, is not, I conceive, the best for accomplishing the object. To arrive at the true pressure, it appears to me necessary to avoid the conical shape of the valve, and the blowing of the steam. To effect this, the valve must be set aside, or appropriated exclusively to its more legitimate use, viz., the emission of the surplus steam, and the spring balance applied to a cylin-

drical piston having a known diameter. The lever not being essential, may be dispensed with, unless perhaps it is introduced to magnify the divisions on the graduated scale, and the cylindrical piston allowed to act directly against the spring of the balance, care being taken to interpose some non-conducting substance, so that the spring shall not come in so close contact with the boiler as to have its elasticity affected by the heat. The contraction or expansion of the spring, as shown by an index upon a scale previously graduated by the application of known weights or pressures, will give the actual pressure without any correction. An instrument constructed in this manner, will possess the peculiar advantage of showing the pressure at all times, whether that pressure is *greater* or *less* than the resistance opposed by the valve.

It will readily be seen that the valve, as ordinarily constructed, affords but an unsatisfactory indication of the actual elastic force, or pressure of the steam, particularly in those cases where, for the purpose of experiment, it is desirable to maintain the force of the steam at a given point. When the steam is blowing from the valve, it is evident that its elastic force *exceeds* the resistance presented by the valve, but how much it exceeds, although perhaps a tolerably correct judgment may be formed, cannot be correctly ascertained. When the force of the steam is insufficient to raise the valve from its seat, and there is no blowing, all that is known with certainty, so long as the resistance of the valve continues unchanged, is, that the elastic force of the steam is *less* than the resistance of the valve. How much less cannot be precisely told.

As the exact measure of the pressure of the steam lies at the foundation of a correct analysis of the powers of the Locomotive Engine, all deductions from experiments made under an erroneous measurement of the pressure must be "defective;" and hence, the importance of examining closely the mode of "conducting and analyzing" the experiments on this branch of the subject.

There is another point, and it is the only one which I propose to notice at the present time, in which there is evidently a defect in the formula of De Pambour. That formula, even "within the limits in which it is properly applicable," assumes as constant and invariable, one of its chief elements which possesses an opposite character. I allude now to the value of S, the effective evaporating power of the Engine in cubic feet per hour.

Owing to the manner in which the blast is produced in a locomotive Engine, by discharging the waste steam into the smoke pipe, it follows that the blast is increased, and consequently (the kind and quality of the fuel remaining the same) the evaporating power of the Engine is also increased under an increase of speed.

Hence it is, that although the formula of De Pambour may give results with tolerable correctness for those velocities and pressures corresponding with the mean velocities and pressures derived from the experiments, yet in proportion as there is a departure from those velocities, there will be a deviation from the truth in the results. In consequence of these deviations, the absolute power of the Engine is greater for the higher velocities and less for the lower than is indicated by the formula. The experiments of De Pambour do not enable us to ascertain with certainty the increase in the evaporation, and consequent augmentation of power, compared with the increase in the velocity. That it is considerable, is evident from the table of experiments, p. 154, where it appears that the *effective* evaporation per hour in the Atlas Engine was for a speed of fifteen miles per hour 36·23 cubic feet, and at 8·99 miles per hour only 30·19 cubic feet.

The average effective pressure of steam in the boiler being in the first case 53·7 lbs. and in the latter 53 lbs per square inch, a difference too small to have any sensible influence upon the evaporation.—Hence the difference in the evaporation must be attributable mainly to the difference in the velocity. This great difference in the evaporation amounting, in the present instance, to 20 per cent. more at 15 than at 8·99 miles per hour, is not recognized in the formula of De Pambour,—the quantity S, representing it, being there assumed as constant at all velocities. When, therefore, we consider that under an increase of velocity beyond the 15 miles mentioned in the experiment, the difference in the evaporating power will be increased in a still greater degree than is above stated, it is obvious that a formula which does not recognize so great a difference must be "defective."

This difference in the evaporating power, under different velocities, is farther shown in the cases of the Firefly and Leeds Engines, in the table above referred to: the first evaporating 44·23 cubic feet at a speed of 17·70 miles per hour, and 52·40 cubic feet at a speed of 21·33 miles, and the latter evaporating 45·39 cubic feet, at a speed of 18·63 miles, and 47·56 cubic feet at a speed of 21·99 miles per hour—the difference in the pressure being in both cases, as in the preceding one, too small to affect sensibly the evaporation.

The two experiments recorded in the same table, made with the Fury Engine, are an exception to the above; but there evidently is one, if not both, of them erroneous, since upon the same day, under the same pressure, with less speed, and less load, the evaporation in one case is 6 per cent *greater* than in the other, instead of being *less*, as it evidently should be.

Unfortunately, the experiments upon this very important branch of the subject by De Pambour are few in number, and insufficient to determine with certainty the law of increase of evaporation under an increase of velocity. Enough, however, can be gathered to show, that in framing a formula applicable to different velocities, the difference in the evaporating power cannot, as is done by De Pambour, be safely neglected.

The *effective* evaporating power stated above, as obtained by experiment, is the total amount of water consumed in each case, as per the table referred to, less by its one-fourth part—that being the proportion *assumed* by De Pambour as proper to be deducted for waste by leakage and escape of surplus steam, &c. Whether there is on the average, this large per centage of waste in all, or in a majority, of the recently constructed and more improved Engines, may, perhaps, be doubted. So large an amount *arbitrarily* thrown away in all conditions of the Engine, must, when there is any great difference in condition,* produce a corresponding difference

* It should be borne in mind, that the *assumption* of an *average* loss, in all conditions of an Engine, by leakage, escape of surplus steam, &c. of one-fourth or 25 per cent., is an acknowledgement that the *actual* loss is as much and as often *greater* as *less* than that amount. Instead of there being all this great loss by leakage, &c. it may yet perhaps be found that the total resistance on the piston, and, consequently, the actual pressure of the steam in the cylinders, has not been correctly ascertained. The force of reaction of the steam, while effecting its escape from the cylinder, is, I apprehend, of more consequence than has generally been supposed. This force, forming as it does part of the value of R, or the resistance to be overcome by the pressure of the steam, cannot, in arriving at a correct expression of the conditions under which the two opposing forces equilibrate on the piston, be with propriety omitted. This resistance is not embraced in De Pambour's analysis, and his experiments do not afford the means of ascertaining its amount. De Pambour did not, if I recollect rightly, determine the relation between the actual distance passed over by

in the estimate of its power. That this difference is great, there is reason to infer from a comparison of the *effective* evaporating power of the Vulcan and Leeds Engine,(experiment 2d) in the table referred to. These two Engines running nearly at the same velocity, (22·99 and 21·99 miles,) drawing nearly equal loads, (39·07 and 37·51 tons,) with nearly the same effective pressure, (54½° and 49°,) having nearly the same amount of heating surface, (136 and 137 square feet.) the surface exposed to the radiating heat bearing the same ratio to that exposed to the communicative heat, in the one case as in the other, viz: 10 per cent.; yet the former, notwithstanding this near approach to equality in all the attendant circumstances, appears to have evaporated 10 per cent. less per hour than the latter—the *total* evaporation in the former case being 57·92, and in the latter 63·41 cubic feet. So also in the cases of the first experiment of the Leeds and Fury Engines, where there is a near approach to equality in the attendant circumstances, the difference is about 15 per cent., which must be mainly accounted for in the difference in the condition of the Engines at the time the experiments were made.

De Pambour, in arriving at the proportion or relation of the heating surface to the evaporation which he has incorporated in his formula, takes the average of the experiments contained in the table above referred to, p. 154. How near the result in each case corresponds with the result by his rule, *deduced from the same experiments*, the following table will show:—

No.	Name of Engine.	Velocity in miles per hour.	Av. effective pressure in lbs. per sq. in. in Boiler.	Effective evaporative power in cub. ft. per hour.		Dif. cub. ft.	Per centage difference
				By Experiment.	By De Pambour's Rule.		
1	Vulcan	22·99	54½	43·44	40·8	+ 2·64	+ 6
2	Atlas	8·99	53·7	30·19	39·0	— 8·81	—29
3	do.	15·00	53	36·23	39·0	— 2·78	— 8
4	do.	15·53	30	34·89	39·0	— 4·11	—12
5	Fury	19·67	57	39·02	40·2	— 1·18	— 3
6	do.	18·63	57	41·27	40·2	+ 1·07	+ 2⅔
7	Firefly	17·70	44	44·23	40·5	— 3·73	— 8⅓
8	do.	21·33	49	52·40	40·5	+11·90	+23
9	Vesta	27·23	51	45·75	39·3	+ 6·45	+14
10	Leeds	18·63	54	45·39	41·1	+ 4·29	+ 9½
11	do.	21·99	49	47·56	41·1	+ 6·46	+13⅔

The greatest differences between the experimental results and those obtained by the rule, occur, as would naturally be expected, under the higher and lower velocities: the difference for the minimum velocity, (8·99 miles) being 29 per cent. greater, and for the maximum velocity (27·23 miles) 14 per cent. less than the truth. Precisely, therefore, in the same ratio will the velocities obtained by the formula (other things being equal) differ from the truth in the cases mentioned. Take, for example, the first experiment with the Atlas Engine,—the velocity corres-

the engine, and the distance due to the number of revolutions of the driving wheels. There is reason to believe that under certain conditions of the rails andrates of speed, and amount of load of the engine, the d fference is considerable, and may perhaps account *in part* for the great consumption of steam over and above what is due to the number of revolutions as deduced from the distance.

ponding to the maximum load for this Engine, using the expression

$$V=\frac{m\,SD}{d^2l}$$

and adopting De Pambour's rule for obtaining the value of S, is

$$V=\frac{415\times35\times5}{1^2\times1\frac{1}{3}}=11{\cdot}49$$

miles per hour. Taking the value of S, as found by experiment, and there results

$$V=\frac{415\times30{\cdot}19\times5}{1^2\times1\frac{1}{3}}=8{\cdot}89$$

miles per hour. In like manner the velocity corresponding to the maximum load of the Vesta Engine, instead of being 13·5* miles per hour, as computed by Mr. Detmold under the formula, is probably considerably less than that amount. This is also obvious from the fact, that in the second experiment preceding the one which Mr. Detmold has quoted, and on the same page, the load of this Engine, reduced to a level, under very nearly the same pressure, is only 129 tons, or 60 tons less than the maximum load of 189 tons—the velocity being 12·1 miles per hour, or 1·4 miles per hour less than the computation of Mr. Detmold, showing that at that low rate of motion, the speed was not reduced down to the point corresponding to the maximum load.

The very great importance of arriving at a correct estimate of the evaporating power of an Engine, in determining the velocities for given loads, and vice versa, is evident from an inspection of the general formulæ given by De Pambour for that purpose. Thus, for determining the velocity V, which an Engine of known proportions will take, when working at a given pressure and drawing a given load, the formula is

$$V=\frac{m\mathrm{PSD}}{(\mathrm{F}+9+\mathrm{M})\,\mathrm{D}+pd^2l}$$

It is unnecessary to repeat here what particular quantities the several letters in this formula represent, any farther than to say that the factor S represents the effective evaporating power in cubic feet per hour. It is obvious that the value of V, the other quantities remaining the same, is precisely proportional to that of S, that is, as S is greater or less, so also will V be greater or less, and in the same ratio.

In determining also the load (M) which an Engine will be able to draw with a known pressure, and at a determined velocity, we have

$$\mathrm{M}=\frac{m\mathrm{PSD}-pd^2\mathrm{V}}{9\mathrm{VD}}-\frac{\mathrm{F}}{9}$$

In this, as in the preceding case, the quantity S holds a prominent place in the equation, the value of M being greater or less as that of S is increased or diminished, although not in the same proportion.

I have shown, I believe, conclusively, that great discrepancies must unavoidably take place between the actual results, and results obtained by the formula. I am aware that instances may be adduced where there is a near coincidence, but there are many others in which the deviation is so great as to render the formula, in cases where great accuracy is required, of little or no practical use.

* There is a clerical inaccuracy in Mr. Detmold's computation. The true velocity by the formula is a little less than he represents it.

De Pambour remarks with justice, p. 143, that "the power of an Engine resides, at the same time, both in the greater or smaller quantity of steam generated, and in the degree of pressure or elastic force of that steam." I have, I believe, shown that there are defects in his mode of arriving at a correct measure of both these chief elements, defects which exist both in the "mode of conducting and analyzing his experiments."

Having already extended this communication beyond what I intended when I sat down, I will conclude, by repeating the opinions expressed in the remarks which have been the subject of the over-hasty, and may I not with propriety add, somewhat captious criticism of Mr. Detmold, viz., "that the subject of the principles of operation and mode of construction of locomotive Engines is one of great importance. De Pambour has done much, *very much*, towards adding to the stock of knowledge upon the subject. His experiments are valuable, *but they require to be extended and carefully revised.*"

E. F. Johnson.

New-York City, September, 1838.

Remarks on De Pambour's Formula.

Messrs. Editors:—The object of my communication, 15th June, published in the third number of your Journal, was to defend the valuable formulæ of De Pambour from the charge of being erroneous and false, which had been indiscriminately pronounced by Mr. W. H. Talcott, and not to enter into a personal discussion. Quibbling and bandying words have never yet drawn a single truth from science, and as Mr. Talcott's letter of August 29th, is mostly written in that "key," we shall pass unnoticed that part where he endeavours to shelter his total misconception of the principles of Locomotive Engines behind the trifling inaccuracy in the copying of figures from De Pambour, which accidentally occurred in our first communication, having taken, instead of 56·5, the number 58, which stands just above it in the table of experiments. The unimportant difference resulting therefrom, is $4\frac{1}{2}$ tons in 191, and to every person in the least acquainted with the subject, it will be evident that this cannot in the slightest degree affect the principle in question.

In the 4th paragraph of his communication of August 29th, Mr. Talcott seems astonished that an Engine which is able to draw its maximum load, with a velocity of 13·03 miles per hour, should not be able to move more than the same load at a velocity reduced to less than one-fourth. To this we can only reply, (as we have already in our first communication quoted from De Pambour) that whenever an Engine moves its *maximum load*, the pressure of the steam in the cylinder becomes equal to that in the boiler; and so soon as this is the case "there is no further diminution of velocity that will permit to increase the load, for an increase of load requires an increase of moving power, which is no longer possible."

Mr. Talcott then attempts to show that the load of an Engine can be increased beyond its maximum, as determined by De Pambour's formula, from the single fact that in one of the experiments the Vesta Engine drew 189 tons, when, according to the formula, its maximum load would only be 186·4 tons. This trifling difference of $2\frac{1}{2}$ tons in 186, being about $1\frac{1}{3}$ per cent., can certainly not induce any one to doubt the correctness of the formula. In fact, as De Pambour himself suggests, "if the result of the experiment seems a little larger than that deduced from calculation, it is

because he has reckoned the tender at an invariable weight of 5 tons—whereas during this experiment the consumption of water and coke must have made it descend considerably below that weight, though he had no possibility of weighing the tender, and consequently could not take the difference into account"—(vide De Pambour, chap. VI. §4). Suppose now that the average weight of the tender had been only $4\frac{1}{4}$ tons, instead of 5 tons, as De Pambour assumed, then as the experiment was performed upon a plane of $\frac{1}{88}$, the gravity of this $\frac{3}{4}$ ton would have been 18·8 lbs., which is equal to the traction of 2·4 tons on a level. Thus, the difference between the maximum load of the engine, as determined by the formula, 186·4, and the result of the experiment, 189 tons, is clearly accounted for.

As to Mr. Talcott's first query, "how is it that this Engine, which should be able to draw 186·4 tons, at 13·3 miles per hour, can only draw 129 tons at the rate of 12 miles per hour?" We reply, that this Engine *did* draw more, for on the 1st August it drew 165 tons, with a velocity of 14·11 miles an hour, and a pressure of 55lbs. (vide De Pambour's experiments). Yet, Mr. Talcott thinks fit to omit this experiment when, as he says, he "gives the results of *all the experiments* made by De Pambour with this Engine, when the load was so great that it could not reach a speed of 13 miles per hour." It is evident, therefore, that as the Engine drew 165 tons, with a velocity of 14·11 miles per hour, and a pressure of 55lbs, it could not have been working in its right state when it only drew 129 tons at 12 miles an hour with an increased pressure of $56\frac{1}{2}$lbs, consequently, this experiment is not at all in point. This, and what we have said before, will also solve Mr. Talcott's second query.

As to the experiment of De Pambour, which Mr. Talcott states to vary from 10 to 100 per cent. from the results obtained by the formula, it must be borne in mind that these experiments have no bearing whatever upon the correctness of the formula, which are intended only to furnish the principles upon which the proportions and effects of locomotive Engines must be determined *when the Engine works in the right state.* Circumstances will frequently occur that may cause the Engine to perform less than it would if working in its right state; and such must evidently have been the case in many of the experiments adduced by De Pambour. In fact, the only reason why he has communicated them, as he himself says, is "to show what may be expected from Engines in their daily work." —And he furthermore explains, in the most lucid manner, in Chap. V. sec. 4, many of the circumstances which may cause the effect of the Engine to be diminished, and the reason why "in the experiments we see the speed go sometimes down to two and three miles an hour." In a word, De Pambour's formulæ show what Engines can do and ought to do, and not what, under *ordinary management*, they really do.

Mr. Talcott states that De Pambour, in one of his practical tables, has employed the formula

$$V = \frac{m\text{PSD}}{(\text{F}+9\text{M})\,\text{D}+\varepsilon d^2 l}$$

in the same manner with himself and Mr. Johnson, and obtained a result where the resistance on the piston is greater than the pressure of the steam that is to move it. This, however, is not the case; De Pambour could not have been guilty of such an absurdity, against which he so repeatedly cautions. We cannot better refute this charge, than by quoting De Pambour's own words, preceding the practical table of the velocity of Engines with given loads, &c., in which Mr. Talcott has descried the error. "As

we have been necessarily obliged to confine ourselves, in each column, to the limit of the load which the Engine is capable of drawing at the pressure indicated after the formula in section 4,

$$\left(M=\frac{(P-\varepsilon)\ d^2 l}{(\varepsilon+n)\ D}-\frac{F}{\varepsilon+n}\right)$$

so it follows, that the same table gives equally the maximum loads for each pressure, as well as their corresponding velocity."

The instance to which Mr. Talcott alludes, occurs in that table, where the maximum load of an Engine, with 12 inch cylinders, 16 inch stroke, 5 feet wheels, 152 lbs. friction, and 42 lbs. effective evaporating power, with an effective pressure of 60 lbs., is given as 255 tons, with a corresponding velocity of 10·91 miles an hour, when it should have been 238 tons, with a velocity of 11·3 miles an hour. This error does not arise from De Pambour's misapplying his own formula, as Mr. Talcott would have us believe, but from the simple fact, that De Pambour, in the computation of this case, according to the last mentioned formula, has inadvertently omitted to subtract the last term $\frac{F}{\varepsilon+n}$, which produced the result of 255 tons, as stated in the table.

Mr. Talcott seems entirely to have forgotten that, in our first communication, where we change the above equation to obtain the resistance on the pistons, in the imaginary case of Mr. Johnson's Engine, we did so intentionally, and with the view of showing *him* that the formula worked right both ways, for *he* in his first letter to Mr. Johnson had taken the paradoxical position, that the formula in one way, when applied to determine the load, is totally wrong; and in the other, when applied to determine the resistance on the piston, "not precisely correct, inasmuch as no allowance is made for the imperfect application of the Engine's power through the crank motion. Mr. Talcott's sole objection, then, to the entire correctness of the formula, when applied to determine the resistance on the piston, is the antiquated error of loss of power in Steam Engines, by the transmission of the motion through the crank, which the merest tyro in the profession, now-a-days, can demonstrate to the contrary.

Mr. Talcott closes his communication with a most disingenuous attempt to condemn De Pambour out of his own mouth, and to lower the value of his work by quoting a passage from the preface, where, he says, that he "by no means pretends to have produced a perfect work."—Surely this remark does not testify against the correctness of the principles which De Pambour has established; and every liberal mind will at once perceive that it was prompted by that modesty which invariably accompanies true merit and learning, and which differs so widely from that self-sufficiency with which Mr. Talcott, in his first letter, pretends to "disseminate nothing but correct information on this subject."

This discussion has already been protracted to an unnecessary length, and it may be almost deemed presumption in us to fill the pages of your Journal with a defence of De Pambour, after such men as Professor Barlow, Professor Whewell, and Nicholas Wood have, in their works, borne unqualified testimony to the distinguished merits of De Pambour, and expressed their entire confidence in the results at which he has arrived. But Mr. Talcott told us in his first communication, that it would be easy to *show* wherein the formulæ are wrong, and that he designs to do so hereafter; and Mr. Johnson, in his comments upon that commu-

nication, tells us that Mr. Talcott "feels confident that he will be able to present correct formulæ for all practical velocities." Now, *this we call upon him to attempt*, and when the errors are pointed out to us, and the *correct* formulæ laid down, we promise them a careful examination, without reference to the "feelings" of any one. In the meantime we confidently predict, that the more profound the research which investigates De Pambour's formulæ, and the more rigid the comparison of the results with *appropriate* experiments, the more complete will be the conviction of their sterling accuracy.

Very respectfully your's, C. E. Detmold.

October 9th, 1838.

Description of the Construction of the First Division of the Long Island Railroad, with Remarks. By an Engineer.

(Continued from page 217.)

Two modes of laying the sills for the superstructure have been mentioned: one with single, and one with double sills. When single sills or plank was used, they were either of three or four inches in depth, and at the junctions of rails, as well as at the junctions of sills, additional pieces of plank, of three to four feet in length, were laid to strengthen these points, as shown at B and C, in figures 2, 3 and 4. In practice it will be found difficult to make the bottom of the sleeper, and the three pieces of plank at C to coincide; it will also be found difficult to make the beds or sand, on which these planks rest, equally solid throughout; the result is, that the sleeper, instead of resting on the three, rests probably in the first instance on one, and therefore settles to a degree with the first load which passes over it. It was thought that a firmer road, possessing a more equal bearing throughout, could be made by using two planks, one laid on the top of the other, and breaking joints; that is to say, the joint of the one plank never corresponding with the joint of the other. So much additional plank is applied at the junction points where single planks are used, that the application of double plank throughout increases but slightly the expense: the planks vary from 10 to 18 feet in length, they may average 15 feet each—this will give 352 planks to the mile; there will consequently be 352 junctions having additional pieces, as shown at B, each three feet in length, or taken together, six feet. The iron rails being 16 feet each, there will also occur 352 junctions of rails having additional pieces, as shown at C, each three feet long, or both, six feet; if the plank averages 9 inches in width and 3 in depth, we have $352 + 352 = 704$ pieces $\times$ by 6 feet, $= 4224$ feet of plank, $= 9504$ square feet of timber; when double sills are used the additional plank amounts to 5,280 lineal feet of plank, $= 11{,}046$ square feet of timber; the additional timber used with double plank, or the difference being thus, 1,542 sq. feet, or including both rails, 3,084 sq. feet, which estimated at $14 per thousand gives an amount of $43 17. The double plank will be greatly strengthened at the junction sleepers, by driving a couple of spikes through both planks, one on each side of the sleeper.

The sleepers used on the Long Island road, and also on the Boston and Providence, and the Stonington roads, are of the white cedar tree. There are two trees of this name; one, the white cedar proper, which is found along the coast from South Carolina to Connecticut, but never farther north than this last State. The other, from which these sleepers are obtained, is more properly termed the '*Arbor vitæ*,' and is known by

that name in the northern States, as well as by the name of the white cedar; it is found plentifully in Vermont, Maine, and Lower Canada. The sleepers were procured from the neighbourhood of Bangor, in the State of Maine. A far superior wood, however, and the hardest and most durable which I have seen applied to this use, is that laid on the Jamaica railroad. The sleepers laid on the Brooklyn and Jamaica railroad are of red cedar; this is a much tougher, more durable, and in every respect superior wood to the white cedar; it is the '*Tuniperus Virginiani*,' which grows abundantly in Virginia and on the borders of Lake Champlain. I have not learned where the Jamaica sleepers were obtained. The hemlock, from which the longitudinal ground sills are procured, is found abundantly in the States of Maine and Vermont; it is also found on the banks of the Hudson, in New-York, on the Catskill mountains. That used on the Long Island railroad was procured in part from Maine, and in part from New-York. The sleepers used at the junctions of the rails are always the largest; even with this advantage, however, and the additional plank laid at the same points, the road is evidently weak there, and may, in many instances, be observed slightly to give with every train which passes over it. The general looseness of the spikes at the junction sleepers, will farther evidence this assertion; and on the road the gravel or sand about the junction sleepers will often be observed to be loose and shaken, while that in contact with the intermediate sleepers is unaffected; it is very evident, therefore, that the additional means used at present to strengthen the points where a junction of rails occurs, are not sufficient. The mode of connecting the chair to the sleeper is indeed defective, but this is not the only cause of the evil; were the chair so secured that the spikes could not loosen, the strokes which the sleeper and its foundation receive on the passage of every train, would be less severe, because the weight, and the resistance of the earth by which it is surrounded, would present united a greater obstacle to the elasticity of the rail than occurs at present with spikes so easily loosened or removed; but had the foundation itself been sufficient, there should not in the first instance have been any movement of the rail, and hence no vertical strain on the spikes to loosen or raise them; the strain being less on the other sleepers, and the weight of the train disturbed in their case by the unbroken rail, over several, instead of being altogether received by one, they are rarely affected in comparison. To remedy this evil on a wooden superstructure, to which our remarks are confined, the Engineer of the Baltimore and Susquehanna railroad has adopted what, in connexion with the provisions now made, would appear to be a very efficient plan. It consists in applying two sleepers at this particular point, and thus distributing or reducing the weight and strain for the one sleeper, or for an equal base, one-half; the manner of effecting this is shown at figure 17, where *a a* are the sleepers, (which on that road rest on broken stone) *b* a transverse piece of wood, three feet in length, sunk into the sleepers and resting on them; *c* the chair resting on the centre of the cross piece; *d d* the rails, and *e* their point of junction. The weight resting on the rail, and thence on the chair, is evidently communicated thus to two sleepers, instead of one, and therefore these sleepers, and the foundation on which they rest, support respectively but one-half of the weight which would be encountered were there but one sleeper in their place; or viewing the space now occupied, the base at the junction is about tripled. On the intervening points, the sleepers meet the rail in the ordinary way. It will be perceived that by this mode

the junction sleepers must always be placed lower than the intermediate sleepers, and that therefore with a plank foundation, there would occur a break in the continuity of the sills at every junction; this, however, may be obviated, and the same advantages secured with a foundation of continuous sills, by using instead of the pieces of timber *b*, and the chair *c*, a casting which shall combine both without requiring to be sunk more than an inch into the sleepers, and therefore without weakening them so much as at present; the centre of the casting would be raised to receive the ends of the rails, and prevent them from resting on any point but the centre, and in this way, the ends resting on either sleeper, the weight would be distributed just as it is at present. These castings, however, would be so heavy, and therefore so expensive, as to be out of the question at present; we are therefore, driven, again either to rest satisfied with the single sleeper, or to modify Mr. Trimble's mode of using timber, so as to render it applicable to a sill foundation. It is obvious that the benefit obtained by this plan, is altogether in proportion to the distance between the two sleepers, supposing always the transverse beam to be inflexible; and it may be considered so practically, on three or four feet of distance. If we had a single sleeper occupying the same width as the two sleepers, the same disadvantages would obviously be obtained, the bearing would be increased in the same proportion, the weight would rest on a space equally great. Figure 18 shows a mode by which the advantage might be gained; the transverse beam *a a a* rests solidly on the sills; it is connected to two sleepers, *b b*, for the purpose of securing its position, and preventing lateral displacement. The sleepers are notched and countersunk into the transverse beam, which may itself be a piece of a heavy sleeper: the depth 8 inches, and the width 10; the space between the sleepers may be 2½ or 3 feet; the bearings of ordinary sleepers do not exceed 8 inches: these, therefore, would exceed them in the proportion of rather more than four to one, and being efficiently held in place by the connecting sleepers, would be equally secure in that respect. The chair would then be laid on the centre of the beam at *c*, in the usual way.

I have now to propose a modification of the chair in use, but will first request attention to a short description of the superstructure of the Jamaica railroad, as designed and constructed by Mr. Douglas. Fig. 26 represents the rail of the Jamaica road, and figs. 23 and 24 the corresponding chair; the projection on the base of the chair admits of the surface of the rail occupying a lower, and therefore firmer position, with respect to the sleeper on which it rests, than it otherwise could do This projection is neatly fitted into a corresponding notch in the sleeper; the rail is thus rendered exceedingly secure from displacement laterally; the lateral strain is now thrown directly and immediately on the sleeper, instead of through the intervention of the spikes as formerly,—the spikes being exempted from this particular force, may be made much smaller, and for this chair a screw nail of about ⅜ inch diameter is used instead of a spike—it will weigh less than ⅓ of the weight of the common spike used with the Providence rail: from the form of the chair, however, and its peculiar connexion with the sleeper, this screw is found to answer the purpose very well, and when compared with the spikes before mentioned, is found, under like circumstances, to be less often drawn or displaced. Fig. 25 represents the form and size of this screw. Fig. 27 represents the superstructure as laid on the Jamaica railroad: *a a* being the chairs and rails, the rails 4 feet 8½ inches apart in the clear, *b* the sleeper, and *c c* flat stones, or pieces of paving stone, about 20 inches square and 4

deep, on which the sleepers rest. These stones are laid on the natural earth, whatever that may be. The whole fabric displays more ingenuity and valuable adaptation than any construction of the kind which I have seen; it requires but additional strength, (which Mr. Douglas, I understand, proposes to give it,) and a faithful foundation, to render it the most economical rail at present known.

The chair which I propose to apply, is intended to take advantage of that feature in Mr. Douglas's chair, which relieves the spikes or bolts from the lateral and horizontal strain communicated to the chair, and throws it directly upon the sleeper; this advantage, we believe, can be gained without cutting so deeply into the sleeper as Mr. Douglas has done—no advantage in respect of stability being gained in this case by great depth with the "Long Island" form of rail. The form of chair laid at present on the Long Island railroad, has already been described; it is shown at figs. 8 and 9. The form of chair laid on the Stonington, Boston and Providence railroads, with the same form of rail, is shown at figs. 19 and 20; it differs from the Long Island chair in the situation of the holes for the spikes. The pieces *b b*, fig. 8, on the Long Island chair, fit into corresponding notches in one end of the rail, and prevent the longitudinal motion of the rail, so far as the strain of the machinery is concerned; the rail being, however, confined thus only at one end, its expansion by heat is not prevented. The chair, figs. 19 and 20, has its holes for the spikes so placed, that the spike itself fits into the notches in the rail, which, with this chair, occur at both ends of the rail; the horizontal motion of the rail is therefore prevented in this case, not by a projection in the chair, but immediately by the spikes. In either case the chair must be considered merely as a plate on which the rail rests; when the spikes are loose the rails are loose, or if the two spikes of one rail are loose while the other two remain firm, that rail rises and presents a dangerous obstacle to the cars. It is true that the great strength and stiffness of the rail prevent the ends from differing so much as they otherwise would do, or bending to a dangerous extent in the manner in which plate rails are bent under similar circumstances; there is still danger, however, when the machinery is in rapid motion, of the cars being thrown off the track, even by differences of half or three-quarters of an inch, which sometimes occur with this rail. It will be admitted that the danger would be greatly lessened, if where the one rail was loose, and rose, the other rose simultaneously to the same extent, so that their line of surface should always agree; in other words, that the one rail should not rise without the other. This would be the case were the chair so formed as to connect with and bind the rails; where the spikes or bolts got loose in this case, the rails would carry the chair with them, but the form of the chair would still maintain an uniform connexion at the joints, as may be seen by reference to figs. 21 and 22. In fig. 21, the projection *a* is fixed, and secures one side of the rails; that the rails may be made firm, the other projection *b*, of which *b'* is the same in profile, is moveable, and fits into the projection on the plate *c*, (see also fig. 22 and the profile of this part of the plate,) the hole in which corresponding to the hole in the moveable piece, but a little in advance of it, admits a key of a wedge form, by driving which the piece is forced upon the rails, drives them close upon the opposite side of the chain, and secures them from rising by the form of the point of the moveable piece *b*. The ends of the rails are cut at present by a machine, for they are rarely of the same size at the ends, and it is necessary that they should exactly correspond; *er*. The chairs may always be made to fit the rails within $\frac{1}{12}$ of an inch

on the bed, and therefore there is no occasion for a greater provisional allowance either in the hole or in the key. The nearer all the parts approximate to perfection, as received from the manufactory, of course the better. The projection *d*, fig 21, is intended to fit into a hole of the same size in the sleeper, by which means the bolts or spikes will be relieved, in a great measure, from the lateral strain. The small projections, *d d*, fit into corresponding notches in one end of the rail for the purpose of securing it from longitudinal motion as heretofore: with this chair, screws should be used of about $\frac{1}{2}$ an inch in diameter; experience proves that spikes are too easily raised.—The two screws of this dimension will, combined with the projection, probably render the chair very firm; and as about $\frac{1}{3}$ of the iron used for four spikes will answer in this case, the cost, in this respect, will not be increased. This chair will weigh about 12 lbs.; something more compact will probably occur to others which they would continue to be cut, but this part of the process ought to be perfected at the manufactory, where it can be done both better and cheap- will at once improve the form and reduce the weight. Of the spikes used on the intervening chairs, the ragged form, fig. 12, has proved far the best; something better is however required. The absolute necessity for something better is not indeed so apparent while the same strength and weight of rail is used, yet the spikes frequently get loose, and there is not a little iron wasted in repairing, which is generally done by driving a new spike on another part of the sleeper. The truth is, the stiffness of the rail, if combined with a *firm superstructure*, is greater than there is any occasion for; with an imperfect superstructure it is absolutely necessary,—it reduces and dissipates its defects, for the weight and strain, instead of being communicated to the spikes of one sleeper, is dispersed over three at least, if not partially over the whole rail; while therefore the same weight of rail continues to be used, the same mode of spiking may sufficiently answer.—Should, however, the road be improved in other respects, the weight of rail may safely be reduced, and what was previously due to imperfection of foundation, may then be dispensed with; in that case, a more efficient mode of spiking on the intermediate rests will be found necessary, since the strain communicated to each sleeper and its fastenings will be increased. It is doubtful whether any form of spike will then answer so well, as a small casting on either side of the proper form, binding closely the rail, and secured by a bolt or screw.

The rail laid on the first division of the Long Island road is very massy; with the exception of the Stonington rail, which is $\frac{1}{2}$ lb. per yard heavier, and the Baltimore and Pennsylvania rail, which is $58\frac{1}{2}$ lbs. per yard heavier, it is the strongest rail used in the United States; its simplicity is its prominent characteristic,—chairs are dispensed with except at the junction sleepers, and the rail is easily and securely laid by ordinary hands.—It is particularly applicable to a timber superstructure, and as already remarked, it is enabled to reduce the defects of a temporary and imperfect superstructure by the qualities of uncommon strength and stiffness; the rail is, therefore, practically the best in use in this country. There are many other rails, and particularly the Jamaica rail, which would be greatly superior in every respect, with an efficient and solid superstructure and foundation; but with the superstructures in use, or likely to be in use for some time, they are comparatively easily disarranged;—they are made for a more perfect state of things than now exists, and are therefore not so practically efficient as the other which has taken into account the contingencies and imperfections of the time in which it is laid.

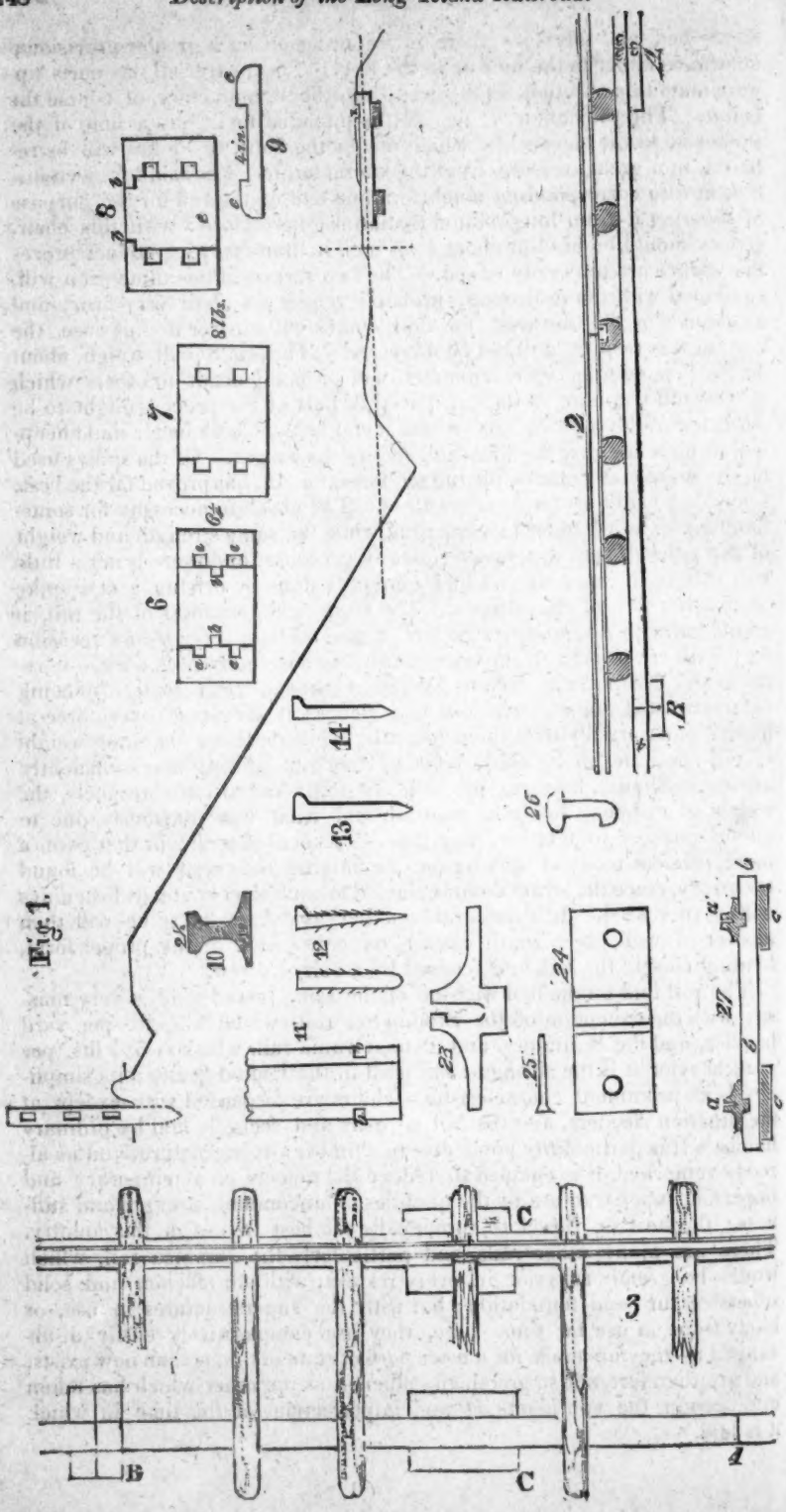
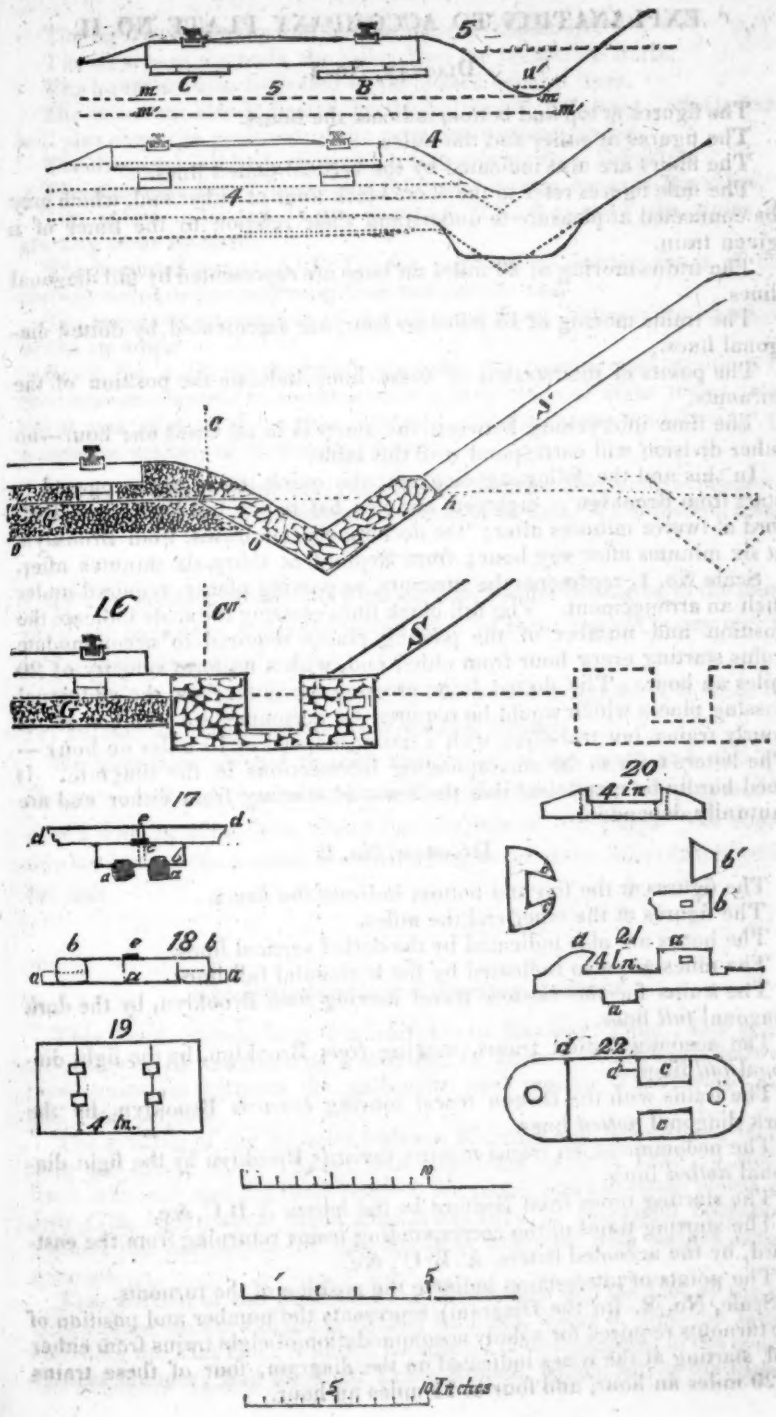


Fig. 1.


5
C
B
4
16
17
18 b
19
20
21
22
4 In.
10 Inches

EXPLANATION TO ACCOMPANY PLATE NO. II.

Diagram, No. 1.

The figures at top and bottom indicate the hours.

The figures at either end the miles.

The hours are also indicated by the vertical dotted lines.

The mile figures refer to the short black lines at either end, which may be connected at pleasure to understand their relation to the times of a given train.

The trains moving at 20 miles an hour, are represented by full diagonal lines.

The trains moving at 15 miles an hour, are represented by dotted diagonal lines.

The points of intersection of these lines indicate the position of the turnouts.

The time intervening between the starts is in all cases one hour—no other division will correspond with this table.

In this and the following diagram, the *quick* trains are supposed to start from Brooklyn at eighteen minutes before any full hour, from Bedford at twelve minutes after; the accommodation trains, from Brooklyn, at six minutes after any hour; from Bedford at thirty-six minutes after.

Scale No. 1, represents the turnouts, or passing places, required under such an arrangement. The full black lines crossing the scale indicate the position and number of the passing places required to accommodate trains starting every hour from either end, with a uniform velocity of 20 miles an hour. The dotted lines crossing the scale show the additional passing places which would be required to accommodate another set of hourly trains, but travelling with a uniform speed of 15 miles an hour.—The letters refer to the corresponding intersections in the diagram. It need hardly be mentioned that the times of starting from either end are mutually dependant.

Diagram, No. 2.

The figures at the top and bottom indicate the *hours*.

The figures at the other end the miles.

The hours are also indicated by the dotted vertical lines.

The miles are also indicated by the horizontal full lines.

The trains for the Boston travel moving *from* Brooklyn, by the dark diagonal *full* lines.

The accommodation trains, moving *from* Brooklyn, by the light diagonal *full* lines.

The trains with the Boston travel moving *towards* Brooklyn, by the dark diagonal *dotted* lines.

The accommodation trains moving *towards* Brooklyn by the light diagonal *dotted* lines.

The starting times from Bedford by the letters A B C, &c.

The starting times of the corresponding trains returning from the eastward, by the accented letters, A′ B′ C′, &c.

The points of intersection indicate the position of the turnouts.

Scale, No. 2, (to the Diagram) represents the number and position of the turnouts required for a daily accommodation of eight trains from either end, starting at the times indicated on the diagram, four of these trains at 20 miles an hour, and four at 15 miles an hour.

DIAGRAM, No. 3.

The figures at the top and bottom indicate the hours.

The figures at the ends, the miles from the respective starts.

The hours are also indicated by the dotted vertical lines.

The miles are also indicated by the horizontal full lines; which lines will also show the positions of the proposed passing places.

The diagonal full lines show the trains moving *from* Brooklyn.

The diagonal dotted lines show the trains moving *towards* Brooklyn.

The points indicated by the letters A B C, &c. show the times of starting from Bedford.

The accented letters, A′ B′ C′, &c. indicate the starting times of the corresponding trains returning from the eastern end.

The points of intersection of the diagonal lines, indicate the positions of the turnouts.

Scale, No. 3, (to the diagram) represents the number and positions of the turnouts required to accommodate a daily trade of eight trains from either end, starting at the time indicated in the diagram, and having all a uniform velocity of 20 miles an hour.

NOTE.—For this mode of exhibiting by diagram the relative positions of trains on a railroad, the writer is indebted to Geo. W. Whistler, Esq.

☞ In making wood cuts from the lithographs belonging to the pamphlet, we have been obliged to curtail some of them, but not in any way to injure their representation.

The first Scale relates to figure 1, the second to figures 2, 3, 4, 5, 15, 17, 18, and 27; the third, to the remaining figures.

We have been obliged to omit the profile of the road, and also the Diagrams referred to as plate II, as from their great size it is impossible, in any way, to bring them within the compass of our page. We regret this the less, as the method of constructing them is so fully described in the text.

The Philadelphia and Reading Railroad.

This Road extends from Philadelphia to Reading, Penn., and is intended, with its extension to Pottsville, to form a continuous Railway communication between the anthracite coal regions of Schuylkill Co. and Philadelphia.

The grading of the 40 miles between Reading and Norristown, including the Black Rock Tunnel, was completed early in 1838; a single track was laid, and the Road opened for travel between those places on July 17th, 1838, since which time it has been in successful operation, without the occurrence of any accident attended with serious consequences.

That portion of the Road between Norristown and the foot of the inclined plane on the Columbia (State) Railroad, where it joins the latter, including the Flat Rock Tunnel, is expected to be completed in the course of next summer; and the Coal Trade Branch, which leaves the former

route at the Schuylkill Falls, about five miles from Philadelphia, and debouches at Richmond, on the Delaware, it is calculated, will be finished simultaneously with the extension of the Road from Reading to Pottsville.

The total length of the Road from Reading to the Delaware is 59 miles; and to its junction with the Columbia Railroad, 53 miles. Reading is about 37 miles from Pottsville.

One of the most important features in this Road, is the uniformity and lightness of its grades, nine of which *ascend* from the Coal Region to Philadelphia, with but one exception, where the high ground between the Schuylkill and Delaware Rivers renders unavoidable an ascending grade of about 1 mile in length. At this point, it is contemplated to have an assistant Locomotive Engine, by the aid of which the trains, with their full loads, will be enabled to ascend without interruption. From the summit of this grade, the descent to the Delaware is about 33 feet to the mile: all the others are either descending, or level. The heaviest grade from Reading to the Delaware, with the above exception, is 18 feet to the mile, for about 17,700 feet; between those points, there are 152,600 feet of level, and the remaining distance is divided into grades, varying from 1·5 to 11·8 feet per mile.

With these grades it is calculated that a Locomotive Engine can, with ease, take 200 tons of coal down the Road, and bring back the empty Cars to the Coal Mines.

The general character of the grading on this Road is heavy, particularly the grading of the first five miles from Reading, where the Road winds round the base of the Neversink Mountain.

About a mile above Phœnixville is the Black Rock Tunnel, the longest in America, which cuts off a bend of the river nearly 3 miles round. It is 1,932 feet long, cut through solid blue slate rock the entire way, 19 feet wide, and 17·2 high. It was worked from the ends, and from 5 vertical shafts, one of which was 140 feet deep from surface of ground to grade of tunnel. It cost $150,000.

On the same line with this Tunnel, and immediately adjoining it, is a beautiful stone bridge across the Schuylkill, with 4 arches of 72 feet span, and 16½ feet rise each, and built throughout of cut sandstone.

At Flat Rock, one mile above Manayunk, is another Tunnel 960 feet long, through solid Gneiss rock, which is now more than one-third completed.

The surface of this Road is 21 feet wide on embankments, and 25 feet in cuts, with side ditches in the latter 1½ feet deep. Its side slopes are 1½ base to 1 rise on embankments; 1 to 1 in earth, and ⅛ to 1 in rock cuts.

In the wood-work of Bridges on this Road, Irvin's Lattice for spans over 40 feet has been adopted; and for spans under that length, the King and Queensport Truss, and simple joist forms—the Lattice Bridges being built of white pine, and the others of white oak, timber.

The Culverts are built of stone throughout, generally with semicircular arches of from 6 to 50 feet span.

The superstructure consists of the T rail, laid upon white oak sills, or sleepers 3 feet 1½ inches apart from centre to centre. The rail is 3¼ inches high,—its upper surface 2¼ inches, and lower 3¼ inches, wide, with a stem ½ inch thick. It is rolled in lengths of 18 feet 9 inches, and weighs 45 lbs. per lineal yard. The sill is 7 feet long, and 7 by 8 inches square, laid on its flat side.

The joints of the rails fit into a cast iron chair, shaped to receive ex-

actly the whole of the under surface, and one side of the end of each rail, which is furnished with a bolt hole, through which, and a corresponding one in the chair, a screw-bolt passes, nutted on the inside, making a perfectly true and level joint, and securing the ends of the rails firmly to the chair. Between the ends, the rail is fastened to the sills by a bill headed ½ lb. spike, which clamps the rail down to a ¼ inch notch cut in the sill: no intermediate chairs being used, as with most other solid rails.

Under the whole length of every sill, a trench 8 feet long is dug, and filled to the depth of 14 inches with broken stone, well rammed, in three separate layers In rock cuts these trenches are, of course, dispensed with, and the sill laid upon the bare rock.

When the unevenness of the country through which the road passes, and the sudden bends of the River Schuylkill, whose valley it follows the entire way, are considered, its curvature will be found remarkably light; the shortest radius of curvature adopted being 819 feet, and but 1480 feet struck with the radius. The other curves generally average from 2000 to 3000 feet radius.

In the excavations of the Road, various geological formations are exposed; as, commencing at Reading, limestone, quartz, breccia, red slate with sandstone intermixed, sandstone, blue greywacke slate, through which the Black Rock Tunnel passes, sandstone and gneiss rock, of which the Manayunk Tunnel is composed.

The scenery on this Road is unsurpassed by any other in the country. Following the course of the Schuylkill, it presents to the traveller those picturesque views for which that River is remarkable: these are of the most diversified character, from the wildest mountain scenery, where the Road winds round the foot of a lofty hill on a narrow ledge cut with immense expense from the solid rock, to the smiling landscape, where fields rich with fertility afford a pleasing contrast on escaping from rugged and precipitous hill sides.

It is thought the Road will be completed from Reading to Philadelphia, via the Columbia Railroad, sometime in the course of next summer or fall; and the whole line to Pottsville in about two years.

The total cost of the Philadelphia and Reading Railroad, when completed, including depots, tunnels, and a double track of edge rails, it is supposed, will be about $45.000 per mile. It was commenced in July, 1835;—Messrs. Moncure & Wirt Robinson, Engineers.

Reading, Sept. 28, 1838.

Remarks on Steam Navigation, Explosions, and Engineers.

From the Army and Navy Chronicle.

The results of the recent passages across the Atlantic by several different vessels propelled by steam, together with the increased facilities in travelling, and the transportation of merchandise secured by this agent, both on our rivers and along our coast, have very justly excited the amazement of the hitherto incredulous, as well as the attention of the enterprising. The practicability of the application of steam for the navigation of the ocean is no longer problematical. Let prejudice and scepticism be henceforth discarded, and the incubus that has lain upon the prosecution of the first successful attempt (some twenty years since) be removed; and let an early prophecy be fulfilled to its widest extent:

"Soon shall thy arm, unconquered steam, afar,
Drag the swift barge or roll the rapid car."

Americans should not have lost sight of their success, and allowed a rival nation to have prosecuted its experiments with a spirit that acquires additional lustre from their supineness. Why American enterprise has succumbed in this instance, is a query that must naturally present itself. Would that an answer could be given, as satisfactory as the character of our countrymen for the possession of such a quality is proverbial. But, as an excuse can be given, and one too that exonerates the majority at the expense of a few, it is but fair that it should be offered.

Steam Navigation, it is well known, on this side of the Atlantic, until within a very few years, with but some temporary exceptions, has been exclusively confined to our bays and our rivers. The comparatively smooth water of the former, and the shallowness of the latter, have induced an appropriate structure of vessel, and form of engine. The one unrivalled in beauty and speed, and the latter in economy and efficiency. Two routes only upon our coast have been established; and the consequence of our want of experience in such navigation, is too deeply felt, and too well known. The owners of the Chancellor Livingstone and New England, at the north, will long regret their temerity, while the loss of the Home and Pulaski will not soon be forgotten at the south. The immediate cause of the destruction of these vessels, with but one exception, has been owing to an improper construction of their hulls, they being too light, and their depth of hold too shallow for the length of keel; for strange as it may appear, the plan and proportions of river steamboats have been carried out, in those intended to navigate the ocean. How then can it be wondered at, that, with the conviction of the impropriety of such a course as that pursued on the part of some few individuals who have catered for the public convenience, British steam navigators should seek to introduce their vessels among us, and that our accustomed enterprise has received a temporary check from the inexperience of some, and the inexcusable temerity of others. That it is but a temporary check, the writer is convinced; and he trusts he is not singular in this position; for, strange as it may appear to those who are unprepared to meet with the assertion, yet it is nevertheless true, that the American steam engine, in its application for the propelling of vessels upon the ocean, and particularly for long voyages, on account of its compactness, speed, efficiency, economy of cost, and fuel, is beyond comparison with those manufactured by any other country. In support of this declaration, he not only defies a refutation, but advances an instance in corroboration, of which it can be truly said—*Ex uno disce omnes.*

The British steam ship Great Western is propelled by engines of 375 horses power, at their ordinary speed and pressure of steam, (which approaches to within a shade of their maximum power;) they occupy a space, including boilers and fire rooms, of 56,100 cubic feet, and weigh, together with the boilers and water, 588 tons, and consume, at the very lowest estimate, one and a quarter tons of coal per hour. Whereas, the United States steam frigate Fulton (built in New-York) has engines of 460 horses power, at their ordinary rate, though capable of being worked to 936 horses, which occupy but 26,622 cubic feet, boilers and fire room also included, weigh but 207 tons, with boilers and water, consume but a like quantity of fuel, although of 85 horses power greater, and drive her wheels at an excess of speed of $2\frac{2}{3}$ of a mile per hour over the Great Western's.

From this difference in proportions, (not only existing in the above cited instance, but being characteristic of the engines of the two countries) it is

evident, that a vessel of the same tonnage and model as the Great Western, having American engines, *could be driven much faster, at a less expense of fuel, as well as first cost, would carry nearly* 30,000 *cubic feet, or* 381 *tons of merchandize more, and yet draw but the same water.* With this advantage in the plan and construction of engines and boilers, together with the admitted superiority of our ship builders, in modelling, as well as ability to build a sea steamer, when not influenced by temerity, or dictated to by the cupidity and ignorance of the employer, the prediction is justly warranted that in a few years, American steamers will hold that station in the navigation of the Atlantic, which the above enumerated advantages in one portion, and the known ability of our shipwrtghts in another portion of the necessary work justify. And if any doubt still exists, either respecting the ability of our countrymen to build both vessels and engines, appropriate for the navigation of the ocean, I know it will soon be dissipated, as the question is abont being settled. Ere many months elapse, there will be an American steamer running from New-York to Cuba, that, from my knowledge of the persons about engaging in her construction, I feel confident of a most gratifying result; also from the description given of the Natchez, lately built at Baltimore, a most creditable success is confidently looked for; and although a first attempt, she is not likely to prove an unworthy one.

Thus much in illustration of the advantages Americans possess in STEAM NAVIGATION; and if you can spare me a column in your next number, I purpose to treat of EXPLOSIONS and ENGINEERS.

No. II.

In the previous number, I undertook to show that sea steamers could be built on this side of the Atlantic, the engines of which, in point of cost and economy of space, in speed, and consequent efficiency, far excel those manufactured in the only country that pretends to approximate to us in the design and construction of them.—But assuming our engines, boilers, and vessels to be all that can be reasonably asked for, or all that we profess to beable to produce, and even such as to throw all competition in the back ground, yet there is another consideration, an obstacle to be overcome, and one that from its magnitude, the neglect of it heretofore, and consequent ill success, deserves, aye demands, most deliberate and provident attention. Need I say, that I allude to the fearful number of explosions of boilers, that are almost weekly occurring upon our different bays and rivers. However, as the question—"Why do the boilers of our boats burst so frequently, and why are there so few accidents of a similar nature occurring in other countries?" is so often and so justly asked, and as a reply can be given which will exonerate my profession, in a great measure, from the onus of censure that is daily heaped upon it, I will give it; for as injurious effects are the results of objectionable and erroneous causes, a knowledge of such errors should induce correction. Before entering on this subject, it is meet to remark that I would have preferred it taken up by a more competent pen than mine; but as a most unaccountable supineness is evinced by older and abler persons, the task devolves upon others; and would that a conviction of the truth of what I shall say, will follow with but one-half the certainty that ruinous and fatal consequences will be attendant upon a neglect of it.

In a brief sense, and in a great majority of instances, EXPLOSIONS of steam boilers originate in the errors and prejudices of the Owners and Directors of steam boats, together with an utter ignorance of the subject on the part of the editors of papers, who, in misdirecting their censure, mislead

the public; for if a boiler explodes, in consequence of *neglect* and *ignorance* on the part of the person having it in charge, it is not him alone that deserves to be the target of public opprobrium; it is the *employer* that is answerable, for his inexcusable temerity and cupidity in employing an incompetent person. Abuse of the unfortunate object who has either lost his life, or situation, and perhaps only means of support, is not the proper channel in which the indignation of the public should be directed. Neither is it one that will effect a remedy. Let him who, from a mistaken notion of economy, and from an utter disregard of the safety of those who trust themselves in his vessel, omits to exercise a due precaution in the selection of his materials or his agents, receive that meed his unfeeling conduct deserves; and if no moral obligation can reach him, let a physical one be enforced, that will render it incumbent upon him to perform those duties, for the fulfilment of which, by the reception of a consideration, he virtually acknowledges his liability. Let the subject be commented on, in the manner and detail that its importance deserves, and there will not only be less space in our newspapers for idle accounts of "steamboat racing," but less necessity for such notices. For, rest assured that so far from steamboat racing being the cause of boilers exploding, it is a reasonable, if not a sure guarantee of safety. Before, however, due credence can be generally expected, for such an assertion, or before treating of the precautions necessary to be observed in the management of boilers, it is necessary to note the causes of their requiring the most delicate and assiduous attention; without a thorough knowledge of which the proper attention is not likely to be bestowed; neither are the wonted remedies in an exigency likely to be resorted to, when the call for them, as well as their effect, is unknown. Where a thorough knowledge of what is termed the practical operation of boilers and engines is combined with full information of the effects of heat at different temperatures upon water and metals, when the proper attention (the natural result of such knowledge) is bestowed, none other than physical defects are to be guarded against; and even these, with a proper eye to the construction of the boiler and dependencies, or fixtures, can be guarded against, so as to render success and safety all but certain.

I have assumed proper attention to be the result of proper knowledge, upon the principle that it is not to be expected that a man would heedlessly pursue a path at night that he knew led to a precipice; or, that knowing the nature and effects of the gas that is set free by the combustion of charcoal, he would be with his head upon a floor where such combustion was in progress.

Boilers are liable to be burst, or exploded. Engineers make a very wide difference in the application of the two words. The former is construed to be the effect of an escape of water, or steam, in consequence of the pressure exceeding the capacity of the boiler to withstand it, (there being a sufficient, or a requisite quantity of water in the boiler.) The latter denotes the instantaneous disruption of the boiler, when from a defect in the feeding apparatus, or inattention on the part of the engineer or firemen, the water has subsided below the flues, or any portion of the boiler through which flame passes, and water is suddenly admitted. This is in consequence of the steam being exposed to the direct action of the heated metal of which the boiler is made, whereby it is deprived of that, or the corresponding elasticity due to its temperature, which it would possess were it shielded from such exposure by the intervention of water. When water is either admitted through the feed pipes, or thrown up by a sudden heel of the vessel, this intensely heated steam receives that moisture which it

requires to give it elasticity, and a pressure is almost momentarily effected that defies restraint. Destruction and death mark its course. This operation is also assisted by the metal (if iron) becoming hardened and partially oxidized, and consequently weakened. When the flues lose the protection of the water, they become intensely hot from the flame upon one side; and being exposed to steam upon the other, the process of oxidation is going on (unless deterred by the presence of "scale.") When water is thrown upon them, the previously exposed portions are hardened, and the tenacity of the metal is almost totally destroyed; thus, increased pressure, and decreased resistance, are the effects of neglect and ignorance in the management of the water in a steam boiler.

Many other causes of explosions might be furnished, in illustration of the necessity for that never-ceasing supervision which boilers and engines require when in operation; but as neither my limits nor leisure will admit of treating them in detail, I must content myself with one other recital. The water in a boiler is liable to "foam:" that is, the water from various causes becomes thrown into a violent state of ebullition, and when the gauge cocks are opened, unless the proper attention is bestowed, it will not be detected. Not only will the necessary, but even a greater quantity of water appear to be indicated; and if the feed cock is opened, the fireman will naturally shut it, perhaps "blow off," and satisfied with having *examined the height of water* for a period, will turn his attention elsewhere; perhaps listen to a tale of some travelling acquaintance or officious querist. In the mean time the quantity of water in the boiler is rapidly decreasing by evaporation, and then the boat approaches a landing, the engine is stopped, the ebullition immediately subsides, and the level of the water falls below that of the flues. The steam becomes highly heated without the steam gauge indicating a corresponding pressure (in consequence of the want of elasticity.) The gauge cocks may, or may not, now be examined, although due regard to safety would imperatively require it, and if examined by the fireman alone, and the water discovered to be below the lowest cock, (generally from four to five inches from the upper surface of the flues) afraid to tell the engineer of his neglect, he runs the chance of there still being an inch or two left over the flues. Perhaps the passengers may have heeled the boat on the side of the gauge cocks, and the lower one vents some water. The engine is now set in operation, (the boat having shoved off,) foaming takes place, the feed cock is opened, the water is thrown or rises upon the heated metal, and all the consequences detailed above, result.

This, together with the one cited above, are admitted to be the most general causes of explosions, and as they clearly show how indispensable attention and information, not usually classed as "*practical*," are requisite, I trust the propriety of not employing any as engineers whose knowledge does not extend beyond the "handling" of an engine, and whose chief merit with many employers is that they are satisfied with a less amount of pay than their predecessors were, (and who, in all probability, were removed to make room for them,) will be evident. I hope to be able to show in another number, that, with the necessary precautions, the services of proper persons can be procured; and that, under their guidance, results will be attained as creditable as the awards of humanity will be certain.

It was not my original intention to have entered into details respecting the cause of explosions; but an exciting interest in the subject has imperceptibly led me on. The subject is one of too much importance for me to handle hurriedly or briefly. With respect to the partial oxidation, of which

I have treated, I am well aware that most chemists will differ with me; but experience, based upon incontestible proofs, has fully guaranteed the truth of such effect to the satisfaction of a majority of engineers.

No. III.

Having treated of explosions, it is now meet to treat of ENGINEERS; and in so doing, I will explain the manner in which these catastrophes should be guarded against, both with a view to suggest a remedy, as well as to support the opinion I have advanced, of the causes to which these effects are mainly to be attributed.

That boilers, when in operation, require the most assiduous attention, combined with practice and skill in their management, is too true, and too obvious, even from what little has been here, or elsewhere, said of the different risks they are subjected to. No intelligent mind can for a moment doubt the absolute and imperative necessity of allowing their management to be entrusted to none others than those, duly qualified to take charge of them, both by a knowledge of the risks, and the requisite attention to avoid them. But with a general concession as to the truth of this, on the part of the public, how few are they who act in accordance with the natural dictates such a conviction should ensure. Is it not the practice among a majority of steamboat owners, to employ men as engineers, who are only entitled to such an appellation from the tenure of the office, and from the possession of the qualifications of such persons? Is not the amount of pay they ask, or are willing to receive, the usual standard by which their merits are compared with each other? Are not men, who have been but a few months filling a subordinate situation under an *Engineer*, frequently appointed to take his place at an advance in their wages of only $5 or $10 per month, making with their previous receipt some $30 or $35; when their predecessors were in the receipt of nearly twice the sum, and were unwilling to remain even at that, because knowing the extent of their responsibilities, they demanded a fair remuneration? Unfortunately, such is often the case.

Again, even when there is a proper spirit in the employer, his want of knowledge of the duties of an engineer leads him into one of the greatest errors; although not as culpable as the one just recited, it is even a more deplorable one, on account of its much greater frequency. I allude to the infatuation that pervades this class of persons, in their determination to employ none but those they term *practical* men. All the qualifications they consider necessary, are a knowledge of the manner in which the boilers are filled with water, steam raised the engine put in operation, and "stopped," or "started," as occasion requires; which, together with being able to repack the piston, &c., to clean the boilers that their own negligence has allowed to become dirty, constitute their sole recommendations; and the more untidy their appearance, the greater the quantity of grease upon their clothes, the greater are thought to be their qualifications.

Now let me ask, does any reasonable, intelligent person for a moment doubt, that there would not be an almost total cessation of the disgraceful and mournful accounts of destruction of human life, by the explosions of steam boilers, that are almost daily gazetted from one end of the Union to the other, if a fair remuneration was offered for the services of Engineers; if none but men having a thorough knowledge of the principle, manufacture, and operation of the steam engine, were deemed worthy of the situation, and duly compensated for such attainments? and the ignorant and reckless beings who alike disgrace their profession and humanity,

were discarded and their places properly filled? Is it natural, I would ask, that a man should be chary of his character and professional reputation, who has but little, if any, stake in society? alike devoid of pride and ambition; whose only care is the procuring of a daily support; and whether in one employ to-day, or in another to-morrow, as long as he receives that support, he recks but little; or should he possess the requisite disposition, it will not guarantee safety when attended with ignorance of his duties. While on the other hand, where a proper pride and ambition are combined with a knowledge of his profession, is it to be expected that he will be neglectful when he knows that death or disgrace will be the consequence? or that he, able to judge of the abilities of his subordinates, would repose confidence in those unworthy of it? Would not the latter be the qualifications sought for by an employer, in other professions and pursuits where pecuniary interests are alone concerned? and why should such be neglected, when both fortunes and lives are at stake?

I have said that editors of newspapers were in a manner also to blame, for in misdirecting their censure, they have misled the public. Such is the case, for if, instead of execrating steamboat racing, and abusing such as have charge of boilers that have *exploded*, they were to publish the Owner or Director of the boat, together with an authenticated account of the affair, public enquiry would be led into the right channel, and beneficial results must follow; or if they were to make some enquiries themselves, they would find that there are several lines of steamboats, both in the Northern and Western waters, on board of any one of the boats composing which, an explosion of a boiler has never taken place; and in pursuing their enquiries still farther, they would find that these boats have been run under the direction either of engineers, or persons possessing the requisite qualifications for such a duty.

Again, I have said that steamboat racing, so far from being the cause of explosions, is a reasonable, if not a sure guarantee of safety. Strange as this may appear, it is yet true. When engineers are "driving" their engines, they must have an unusual pressure of steam to effect it, and to obtain which almost incessant "firing" is necessary; the firemen are constantly in the fire-room attending to the boilers, their hands and eyes are flying alternately to the gauge cocks, steam gauge, and furnaces; the height of the water is momentarily watched, and any defect in the boiler or its dependencies is immediately discovered. Thus ample time is afforded to institute such remedies as occasion may call for, added to which, the anxiety of the engineer leads him to a constant supervision of all connected with his department. And, as it is asserted by many very able engineers, and with some truth too, that it is impossible to *burst* a boiler with the due quantity of water in it, and the engine in full operation, little danger is to be apprehended from this source; the reason alleged is, that boilers, properly built, are not only capable of sustaining a much greater pressure than is ever generated in them, or sought for, but that it would be almost impossible, if not quite so, to raise a sufficient head of steam in the boilers, of the proportions of the past or present day, (I allude to American only,) to burst them with the engine in operation.

In reply to the question given in the first number, respecting the greater frequency of accidents to boilers in this country when compared with those of Europe, an answer is found in the difference of the temperature of the water, pressure of the steam, and the size of the boilers, together with the difference in the quantity of water "carried" in them. In Europe the boilers are much larger, and the water carried in them is

nearly three times the quantity carried in those of this country, for engines of the same power; the pressure of the steam seldom exceeds 5lbs, to the square inch, usually 3½lbs. while with us 40lbs. are frequently carried, and less than 12lbs. is seldom used; I allude to the low pressure or condensing engine, as that is the only description of marine engine used in Europe, and the only kind as yet adapted for long voyages and sea water. The consequence is, that carrying less water, evaporation is more rapid; the level of the water is sooner depressed, affording less time for remedies, if a deficiency in it, or a defect in feeding is discovered; a greater deposition of lime, salts, and acids takes place, and the metal is more liable to be burnt; to guard against the effects of all of which, much greater risks than those of our transatlantic brethren, in consequence of the difference in the plan and operation of them; and if to arrive at the present efficient state of our engines and boilers, it is necessary to incur risks in the proportion of their superiority over others, there is but one course to pursue, and that is, with the risk, to increase the supervision and preventives.

Further, there are a sufficient number of young men in our country, of liberal education, intelligence, and natural mechanical abilities, if the proper incentive was held out to them, to make that their profession, a thorough knowledge of which guarantees them an enviable situation and a liberal support; in the prosecution of which, they would be of an inestimable service to the public at large; and in return would derive an ample reward, in the receipt of these advantages; added to which, our government has already employed some of the members of this profession in the naval service, and many more ere long will be required for similar duties, effecting not only a further demand, but adding a most honorable feature as well as character to the profession.

If, as I have advanced and can prove, *the steam engine of this country is years ahead of that manufactured in Europe, in every particular*, and as it is equally indisputable, that in naval architecture, and navigation, we have no superiors, why then should English steam vessels be allowed to supply that place which our merchantmen have so long and so proudly filled? Is it that we have not engineers sufficiently competent and discreet to take charge of their own work? No, rest assured such is not the case.

Then let American enterprise resume its mantle, and it will be found to assume its accustomed sway, in Atlantic as well as river steam navigation. A Great Western and a British Queen may excite some admiration this side of the water, but if a *Great Eastern* or an *American Eagle* does not ere long excite wonder and chagrin upon the other side of the water, then there is but little truth in the vaticination of A Young Engineer.

(Continued from page 230.)

Minutes and Proceedings of the Institution of Civil Engineers, containing Abstracts of Papers, and of Conversations for the Sessions of 1837.

June 6, 1837.

The President in the Chair.

The subject of forcing air through pipes and of ventilation being resumed, Mr. Cottam stated a case in which a circular blowing machine, having a straight pipe 10 feet in length, and 6 inches in diameter, was

sufficient to supply three furnaces, but that a single elbow rendered it incapable of supplying one.

Mr. Oldham, of the Bank of England, stated, that in all the attempts which he had made to effect any purpose, he always endeavoured to imitate nature. Now nature supplies a large quantity of air slowly heated. He had consequently established a stove with a very large heating surface, and a pump capable of delivering fifty cubic feet per stroke. To get rid of the foul air, he made large openings in the roof, and took care that there should be an abundant supply of air properly heated. The air is brought in at a temperature of 180° F.; thus there is a rapid change of air; and a summer heat is obtained without any sense of oppression. The success which had attended this system during two frightful seasons of typhus and cholera in Dublin, would be attested by many medical men; in the middle of winter he kept the doors and windows open, and threw in abundance of warm air.

"On the Methods of Illuminating Lighthouses, and on a Reciprocating Light; by Capt. Smith, of the Madras Engineers, F.R.S., A.Inst.C.E."

In this paper, Captain Smith details the two different systems of fixed and revolving lights, which are generally adopted, and the objections to which each is liable. In the fixed light, the effect produced is precisely proportioned to the means employed, and none of the light is lost, since none of the reflectors are pointed inland; but in a revolving light, provided the revolution continues complete, part of the light is expended to no purpose. The revolving light is however necessary in many cases, since it is only by a series of flashes and eclipses succeeding in a determined order, that the particular lights on a thickly studded coast can be distinguished from each other.

As a means of obviating the objections to which each is liable, Captain Smith proposes, in places where lighthouses are not numerous, to stop the revolution of the apparatus after a certain portion of the circumference has been traversed, and then to reverse the motion so as to cause the light to reciprocate. The action of the reflectors is thus confined to the sea-side only. By this means, a light may be obtained at five-eighths of the expense usually incurred.

The paper is accompanied by a diagram descriptive of the mechanical contrivance for obtaining this alternating motion.

June 13, 1837.

The PRESIDENT in the Chair.

Mr. Oldham resumed the account of his system of warming and ventilating, and exhibited a model of his stove for heating the air. He was convinced that the expedient of forcing the air by mechanical means must be resorted to. He had raised the temperature of a room 24° F. in one hour; by a spontaneous ventilation he could never obtain a temperature of more than 100° F., but by pumping in the warm air he readily obtained a temperature of 150°F., or 180°F.

Mr. Horne called the attention of the Institution to a lamp which he thought would be peculiarly applicable to lighthouses, or wherever an intense light is required. The usual burners are an inch in diameter;

now he had succeeded in producing a clear white light by a burner of half an inch in diameter. The excellence of the light is due to the complete combustion obtained by making the area of the external equal to the area of the internal apertures. The air thus passes directly to the burner; there is a perfect uniformity of draught, the rapidity of which may be regulated by the height at which the burner is above the bottom of the glass, or chimney. The draught of air being thus supplied with perfect equality to both sides of the wick, a flat and steady flame of two inches in height is obtained, and the force of the draught is sufficient to prevent the flame from touching the edge of the burner, so that the edge is always clean and fit for use.

"A series of Experiments on the Elastic Weight and Strength of Cast Iron Beams; by Francis Bramah, M. Inst. C. E."

This very extensive series of experiments had been undertaken several years ago, with the view of verifying the truth of the theory of Bernouilli, Young, and Tredgold, with respect to the equality of the forces of extension and compression in cast iron within the elastic limit. The experiments are accompanied with a paper fully explaining the method in which they were conducted, and with a drawing of the proving machine.

"A practical Method of forming the Stones of an Elliptic Arch; by William Bald, Civil Engineer, F.R.S.E.; M.R.I.A."

In presenting this paper to the Institution, the author has no object in view but to leave a record of the proceedings of an operation successfully carried into execution more than seventeen years ago. This consists in the application of the well known property of the elliptic, 'that the lines from the foci make equal angles with the tangent at any point.' The moulds are thus traced out by drawing a few straight lines.

This plan was adopted in the construction of a bridge over the Owen-More river, in the west of Ireland; and a model of the two courses of the cutwaters of this bridge was presented to the Institution. In these courses the stones are cut so as to break joint with each other, and the blocks are connected together into one course after the manner so ingeniously devised in the construction of the Eddystone.

The meeting of the Institution was then adjourned to the second Tuesday in January, 1838.

Steam Ships of War.

THE miserably exposed condition of our coast to the attacks of foreign armed steam vessels has been already remarked upon by us. To what an extent the seaboard may be ravaged by them, can be judged from a glance at the present strength of Great Britain in that way. That power has the following named steam vessels:

Of the First Class—The Cyclop and the Gorgon.

Second Class—The Dee, Medea, Rhadamanthus, Phœnix, Salamander, and Messenger.

Third Class—Hermes, Firebrand, Firefly, Megara, Spitfire, Volcano, and Flamer.

Fourth Class—Blazer, Tartarus, Columbia, and Pluto.

Fifth Class—Lightning, Meteor, Confiance, Echo, Albion, Carron, African, and Comet.

Total, twenty-seven!!

Now it will be remembered that these were built, or in active operation, before the experiment of navigation across the Atlantic by steam was determined. That trial being now satisfactorily consummated, the immediate policy of the British Government will be to multiply her armed steam vessels so as to render her force in that capacity consentaneous to the new order of things; and the attitude of Canadian affairs will doubtless expedite her determined action on the subject. France, too, will have her floating armament, multiplied; she has already a bold nucleus to work upon. As a wise and prudent people, we should accommodate ourselves to this new national position. We should not be behind the age in this improvement, much less should we be blind to our safety. An enlightened Congress owes it to the nation to take the earliest steps for the protection of our coast. If the frame work of a dozen steam vessels were laid at once, so much the better. We should not count for the continuance of peace on the forbearance of foreign nations, but on ourselves being prepared for war. We are now in a deplorable state should that calamity occur:—an exposed coast; commerce most lamely protected by a meagre naval force; and seventy thousand savages ready to unbury the hatchet and pounce down on undefended settlements and imperfectly organized forts.—*National Gazette.*

Anecdote of Steam Navigation.—A smart dapper little fellow, with a pattern book under his arm, called in at one of our large carpet warehouses: "I have come, sir, for some orders—here is my pattern book, should be happy to serve you." The proprietor, after turning over the leaves, said to the agent, "Will you have the goodness to leave this book for a day or two, and I will send it to your lodgings." "Bless you, sir, I have no particular lodgings; I arrived in the Great Western, took with me a valise and six clean shirts, only used three on the passage. I have run about from store to store until I have received orders for one thousand pieces of Brussels carpeting; you are the last person I have called upon. I am constantly on my feet—I dine when I am at leisure at any eating house that is nigh, and I pay for my lodging at night—so I have really no settled habitation. I must return in the Great Western to-morrow, as I have been absent from home when I get back full *forty* days—you are the last I have to call upon, and any orders you may please to give me, can be executed and sent to you complete in *six weeks* from this time per steam ship." Commentary is useless—this travelling agent in 24 days from the time he left home, received orders for $100,000 of carpeting.—*N. Y. Eve. Star.*

Canal Enlargement.—We learn by the Lockport papers, that the decisions on the proposals for rebuilding the combined locks, rock excavation, &c. were to be made known last evening. The Democrat and Balance says:

We understand that over *one hundred and fifty* propositions have been received for the work embraced in the notice. A large number of applicants for jobs are in attendance, and as may be inferred from the number of propositions, there has been much competition for the work.

New-York and Albany Railroad.

In Number 7—from an error in printing, and mistake in a word—it would appear that on this road one-tenth of the distance is on a grade *exceeding* 30 feet per mile, whereas no portion of the road exceeds 30 feet per mile. The sentence should read :—

The entire distance from Harlaem River to Albany will be *less* than one hundred and fifty miles, and upon a grade not exceeding 30 feet to a level; seven-tenths will be level or under 20 feet; two-tenths will range from 20 to 29 feet; whilst only one-tenth in different places need *equal* 30 feet; with moderate cuttings and embankments.

The heading on the second and third pages of the Report reads New-York and *Erie*, instead of New-York and *Albany* Railroad.

Baltimore and Ohio Railroad.—A meeting of the Stockholders of this company was held yesterday, which adjourned over to the 19th December next. The reasons for the adjournment were stated by the president, and met with the entire approbation of the meeting. Of one thing we were fully satisfied, that every effort is being made to remove the obstacles in the way of the prosecution of the work, and that these are gradually and certainly yielding to the exertions of the able head of the Company. The road passes through three States, upon the legislation of all which it is dependent, and is affected, as may readily be supposed, by various and often conflicting local interests—to accommodate, conciliate, or overcome which, necessarily requires patience and time. We felt satisfied, yesterday, however, that it would not be long before the work would be recommenced with a clear field before it, and with a certainty of being pushed forward to completion. It is one that involves many difficulties, and the best guarantee of its success will be found in the cordial and unanimous support of the community.—*Baltimore American.*

Railroad Speed and the Mails.—In our paper of yesterday we stated that the great London and Birmingham railroad was completed and thrown open on the 17th ult. and that the distance, 112¼ miles, was traversed in four hours and a half.

At this rate of speed, *and it is moderate and safe on a well constructed road*, the distance between this city and Albany can be traversed, on the construction of the New-York and Albany railroad, in five hours and a quarter, and by the Massachusetts railroads to Boston, within eleven hours.

This experiment fully sustains the Commissioner and Executive Committee of the New-York and Albany Railroad in the opinion advanced by them some time since, "that the United States Mail could be carried on that route in six or eight hours to Albany, and in twelve hours to Boston, and for this facility the general government should pay at least $50,000."

We cordially agree with them even were the sum doubled. The advantages of steam on railroads has not been fully considered. A man, at this rate, will take his dinner in Albany and return to tea, with perfect safety and certainty. At the rates which have been traversed on several railroads in this country, it may be accomplished in half the time, when Express speed is required.—*N. Y. Times.*